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BIOLOGY.—*Biology and war.*[1] RAYMOND PEARL, U. S. Food Administration.

Science is playing a part in the conduct of the present world war far beyond anything ever dreamed of as a possibility before its beginning. The physicist and the chemist have been called into consultation with regard to practically every sort of military activity, both offensive and defensive. They have been asked on the one hand, to devise new mechanisms of destruction, and on the other hand to provide effective means of defense against such measures of annihilation as the enemy has been able to put into operation. The response to these demands has been generous, timely, and effective in all of the countries at war. In view of his contributions in these directions the university professor of physics or chemistry seems in a fair way to attain, when the war is over, a position of respectability and esteem in the world's affairs never before imagined in his wildest dreams. The submarine, the aeroplane, gas warfare, as indeed practically all of the new fighting methods which have been put into operation in the last few years, are highly recondite developments of physical science, using the term in a broad sense to include chemistry, mathematics, and even astronomy, as was pointed out to the Academy in an earlier lecture in this series by Doctor Hale.

One has heard very little about the immediate help rendered by biology in the conduct of the war, except in relation to the

[1] A lecture given before the Washington Academy of Sciences on May 9, 1918.

medical sciences, where the contribution is directly to the salvaging of the human wreckage with which the pathway of war is strewn, and only rather indirectly towards its winning. It is generally taken for granted, and to a considerable extent even by professional biologists, that in the nature of things the biological sciences, other than the medical, can have only rather a remote and indirect relation to the conduct of war.

One purpose of this paper is to make some examination of the biological philosophy of war. It has seemed to me that if one does this, he is likely to come to the conclusion that the ordinary valuation of the relative significance of the physical and chemical problems connected with war as compared with the biological problems is substantially the reverse of the true valuation. To begin with, we should remind ourselves of a distinction which is often forgotten when one attempts to evaluate in military terms the potential contributions of the different sciences to war. Essentially what the physicist and the chemist contribute is towards the creation, development, or perfection of some destructive or protective *mechanism*—at best an inanimate, impersonal machine. But the very essence of a fight is that it is between *living* things. A 120-kilometer gun, or a submarine, or a tank, cannot of and by itself make war. All such engines of destruction are only the secondary implements of war. The primary implements are biological entities—men. Without these entities there neither would nor could be any war. So then, obviously, the primary problems of war are biological problems. They are such problems as why men fight; what kinds of men make the best fighters; what conditions, both internal and external, biological and environmental, conduce to the most effective fighting; and what are the probable biological consequences (including physiological, social, and genetic) of the fight, both to the winner and the loser. This is the sort of problems to which the biological sciences can alone make any significant contribution and they are clearly much more fundamental than those entailed in the designing of a new aeroplane or submarine.

Furthermore, it admits of no doubt that the accumulated knowledge in the field of biology could be utilized in a way to be of

large strategic value. The biological analysis of the events of the war as they pass might be made of direct military importance in the forecasting of the future course of events. An illustration here is found in what has happened in Russia. The collapse of Russia was at bottom not due to any shortage of powder or shot or other secondary requirements of military activity, but it came essenially because a Russian is, in certain respects, a totally different kind of animal from an Englishman, a Frenchman, an Italian, or an American. Because he is a different kind of animal he has throughout his past history reacted to certain sorts of stimuli in a different way than would or did the individual of the other nations mentioned. Any thoughtful student of the biological aspects of history—that neglected branch of science which Frederick Adams Woods has been trying for years to interest people in, under the somewhat forbidding label "historiometry"—could have foretold with considerable precision both as to time and event, or better eventuality, just what Russia's contribution to the cause of the Allies would be.

What I have so far said will serve as a general indication, I hope, of the fact that we have signally failed to make effective use of the contribution to war that biological science, in the broadest sense, is potentially able to make. The indictment here, if there be any, falls upon the class to which I professionally belong. What I wish to do in the remainder of the time at my disposal is to discuss a few of the more important biological problems of war, in the hope that such discussion may serve in some sl ght degree at least to arouse interest in these problems on the part of many biologists much more capable of dealing with them than I am. If this can in any way be accomplished I feel that biology will make to the cause in which we are all vitally interested a contribution second to none.

WHY MEN FIGHT

War constitutes a gigantic experiment in human evolution. For the experimental study of evolution in lower organisms we have many laboratories and institutes. In such laboratories one

studies the effect on the race of modifications in the environment, of crossing the different races, and of various other factors which may be supposed to have a determinative influence in bringing about evolutionary change or modification. A great war performs all these experiments on a stupendous scale with the human organism as material.

In saying this I am not at the moment referring to the relation of natural selection to war. That is a topic to which I shall come later. I am here referring to a very much broader aspect of the question. War is not merely selective (if it be so at all) through elimination by death of men at the front. Its biological effect on the human species is much more profound than anything which could possibly result from any merely selective process. War makes a most complete and far-reaching change in the whole biological environment of the human beings of the countries engaged in it, and if the number of these countries is sufficiently large it affects the whole world. In this regard, it is most nearly comparable to what the geologist calls a catastrophic change in evolutionary history. The reason why war induces so profound a change in human environment is that it disturbs every psychological and social relation of men with each other. For modern civilized man the environment does not mean primarily the climate, the flora, or the geological structure of the place in which he lives. To a very considerable extent civilized man controls and modifies the impingement of the direct physical elements in his environment. The important elements of human environment are those which grow out of the activities of the human mind, or as one may broadly say, the psychological and social elements. These include all the social relations which are built up during years of peace. But war, in and of itself, brings about an entirely new revaluation of all existing social, economic, intellectual, and moral relations. This is true not alone for the combatants, but for all the non-combatant or neutral nations. In a war such as the present one men everywhere begin to reconsider their thought and action about such things as what constitutes proper education for their children, what is a desirable mode of activity for the church, what sort of activities in the

conduct of business may be tolerated, and a thousand other of the complex and manifold relations between human beings.

True evolutionary change in a strict philosophical sense means a definite and permanent alteration in a group of organisms, both in the group as a whole and in the individuals composing it, as individuals. When one uses the term "permanent" in this connection it should, of course, be understood always to carry the qualification, permanent until the conditions which produced the initial evolutionary change themselves become altered. Now human social evolutionary change rests upon two broad general bases instead of the one upon which the organic evolution of lower forms of life depends. Lack of recognition of this fact has been a fruitful source of failure to arrive at philosophically sound conclusions in many discussions of the social evolution of man, undertaken from the biological point of view.

The basic element and limiting factor in organic evolution is the germ plasm. It is at once the race stabilizer and the race initiator. The germ plasm is the physical basis of inheritance in general. Borne in the reproductive cells of the organism it is the one thing which preserves physical continuity between successive generations of organisms. If successive generations are to differ from one another biologically there must be concomitant and equivalent changes in the germ plasm. Genetic and eugenic research has abundantly proven that the germ plasm plays the same rôle in human inheritance and human evolutionary changes that it does in lower organisms. Here one needs only to mention the studies of Galton, Pearson, and Davenport by way of illustration. Many others might be added to the list.

Besides this strictly biological base of the germ plasm there is also another underlying factor in human social evolution which is nearly, if not quite, of as great significance. I refer to that complex of ideas and actions which has been rather badly called "social inheritance." This factor operates in somewhat the following manner. Starting from a germ-plasmic base the individuals composing any social group are biologically differentiated from those forming other social groups. On this account they develop social relations and social institutions of a sort in some

degree unique and peculiar to the group. Once started, these social relations and institutions acquire a sort of inertia which in and of itself tends to stabilize them quite without any conscious activity looking towards stabilization on the part of any of the component individuals in the group. This inertia extends within the group in an extraordinary degree to every sort of social relation, including even the minor conventions. It makes the whole social fabric, which, as we have seen, constitutes a very important element of human environment, extremely resistant to change or alteration of any sort. Ordinary social forces produce but little effect. It requires years of unremitting effort to bring about even mild and minor social reforms or changes in the ordinary normal course of human events. It has taken nearly seventy-five years to get as far forward as we are with the prohibition movement in this country. More strongly socially inherited institutions would be still more difficult to alter. To illustrate the point, let us consider the social-economic institution of interest. It is entirely possible, not to say easy, to conceive a society so organized that credit and the interchange of credit would be effected without the institution of interest. But try to conceive the concrete possibility of putting into actual operation in the civilized world today a system which would do away with interest charges. The mind balks at the thought. The inertia of this institution, its social inheritance, is so strong that to change it would be a task of commensurate relative magnitude somewhat approaching to the task of so changing the germ plasm of the human race that man would have, for example, no vermiform appendix. Both are extremely stable things which cannot be easily or quickly changed by the operation of ordinary forces. Both changes involve an alteration in stably equilibrated systems, and it is a general characteristic of such systems that they do not change either frequently or easily. The inertia of social relations, which is I think a better term than social inheritance, is simply a special case of the general phenomenon of the natural occurrence of systems in stable equilibrium, the manifestations of which in the inorganic world have been so brilliantly expounded by Lawrence J. Henderson in his book *The Order of Nature*. It is

precisely homologous to germ-plasmic inheritance in the biological realm and not less potent in its influence as a stabilizing factor in human social evolution.

The one outstanding cause in present-day civilization which can quickly break the inertia of social institutions and induce changes, and by so doing perform a function in the scheme of social inheritance analogous to that of mutation in physical inheritance, is war. It operates to direct sharp and searching attention to the real significance of every social institution, from the standpoint of national efficiency, national economy, and national well-being. If under such stressed examination change or reform appears to be necessary it rather quickly follows. The inertia of the long established is broken by the conditions of war.

If it would not take us so far afield into philosophy and perhaps even metaphysics I should like to pursue this point further, but I think that perhaps enough has been said to make clear the only thing which is requisite here, which is that if we are profitably to discuss the biological philosophy of war we must recognize that besides the influence of the germ plasm in human affairs we have to deal with another general factor of a social but still essentially biological character, namely the inertia of social relations and institutions themselves, which stabilizes them against sudden or rapid alteration by any but the most catastrophic causes such as great wars.

As a concrete example of the application of what we have been discussing to present conditions, we may take the case of England. Already since the beginning of the war England has passed and ended a stage in its social evolution to which it can never return. The institutions and people of that country in all their outlook on social relations in the widest sense have been essentially and fundamentally changed, and however the war may end, will be permanently different from what they were five years ago. Anyone who will take the trouble to read the recently promulgated program of the English labor party will realize how profound the alteration has been. Or, again, consider the whole history of the Home Rule question. More progress has been

made towards its solution since the beginning of the war than in all the previous struggles with it.

To bring about such changes, which constitute a real and definite step in social evolution, it is not at all necessary that the enemy should win a war. It is war itself which accomplishes these alterations in human relations and human beings. It only need be sufficiently comprehensive in its magnitude, and sufficently long continued in time, to produce definite and permanent evolutionary changes through alterations of social relations and institutions.

There is a further side to the evolutionary aspect of war which we have not yet considered. If we view the matter in terms of nations, not of individuals, it is at once apparent that war is a deliberately planned struggle between biologically unlike groups of individuals for the purpose of maintaining or bettering their status in the general hierarchy of group domination or precedence. A modern war is not entered into casually and without some degree of both spiritual and material preparation. In the nature of the thing itself it cannot be so entered. To make a whole nation want to fight, including all the ignorant, because uninformed, people in it, it is necessary that their emotions be stirred, either by some act or supposed act of an offending nation or else by deliberate emotional propaganda. At the outstart of any war this emotional incentive to belligerency is wholly lacking in a very considerable portion of the populations of the nations involved. It has to be worked up, a process in which the enemy always renders most efficient service, by such things in these latter days as air raids over inoffensive towns, sinking passenger vessels without notice, or in other ways too revolting to mention. Pending the general distribution of rage in the involved populations, the business of war has to be planned and executed by the nation's leaders in as detached and impersonal a manner as any other great business enterprise. This fact, which to a resident of another planet not accustomed to our ways might seem strange, raises two questions: In the first place, why do national leaders enter so coolly, and yet under certain conditions so eagerly, upon such a ghastly business as war; and in the second place, why do

the common people not only permit them to do so, but follow them with all their energies when once the business is well under way? Some biological facts will help us to understand the answers to these questions.

The general biological fact of individual variation is, of course, familiar. No two individual animals of any sort, human or other, are precisely alike. Individuals vary or differ among themselves. Of these variations or differences some are superficial and transitory, but, on the other hand, many have a deep-rooted and ineradicable germinal basis. Perhaps the most general result of modern genetics is to show the extent to which variations, often slight in their external manifestations, have a definite germinal basis, reappearing unaltered again and again in the successive generations arising from the same germinal stock. The same fact of variation holds equally true in respect of races and national groups, provided in the latter case they have existed as socially isolated entities sufficiently long for a distinct feeling of nationality to develop. The variation in national groups involves, as in the individual, all sorts of characters, psychological, social, and moral, as well as physical. In new nations, changes in the psychological, social, and moral characters appear and become fixed by the process of social inheritance sooner than in the strictly physical characters. The fact is that the groups of people, which, in political terminology, are called nations, in the great majority of cases become rather quickly biologically differentiated if they are not so from the beginning of their national life. A German is different from a Frenchman or an Englishman or an Italian. These differences are not merely physical. They involve every mental attitude, appetite, and responsibility, which are the factors governing action.

To recognize the fact of biological differentiation or variation is in no sense to assert difference of position in the evolutionary scale. There is no evidence that among these larger and more developed national groups it is proper to speak of one as superior or inferior to another. Philosophically, all such comparisons of races or national groups are untenable, for the reason that they all involve by implication comparison or measurement with some

absolute and unique base or yardstick. But no such absolute base of social evolutionary comparison exists. For example, even at this late date, someone might conceivably contend that the Germans were superior to the Hottentots, but it would be a difficult thing to prove in general or absolute terms. Measured by common sense standards one would no doubt find that in some respect—physical, or moral, or even perhaps intellectual—the Hottentot is a relatively better man in his environment than the German is in his. Plainly, in order to be just to either the Hottentot or the Hun each should be measured by a different yardstick. But this quite prevents saying in any absolute terms which of the two is the superior race. Like so many other things "it all depends." But this logical difficulty only makes it all the clearer that Hottentots are *different* from Germans.

Not only are the different races and national groups generally different, but broadly speaking, they all want to stay so, and this is what causes all that special sort of trouble, which is war. The resentment against the high-handed imposition of that Prussian "Kultur" which we are all so strenuously opposing, arises not so much from any logically proved defects in this particular brand of Kultur (though parenthetically one may remark that they appear to be sufficiently numerous), but rather because, being different, the people of other nations simply do not want it. They prefer their own particular brand of thought and action. The one fundamental thing which an Englishman or a Frenchman will fight against to the last ditch is any attempt to make him over into a German.

The same feeling is exemplified in every war. We fought bitterly for it in the Civil War. The people who originally settled in the southern portion of the United States were biologically and socially different in several important particulars from those who settled in the northern part. The Southerner fought hard and well for four years to keep from being dominated by the Northerner. He had a strong feeling, which was to a certain extent justifiable, that domination meant the obliteration, for all practical purposes, of certain differences which had up to that time existed between him and his Northern neighbor. The same

feeling was a potent factor in making the Revolution. There was a dawning national consciousness in the colonies which was based upon a beginning of social and biological differentiation. The mother country very unwisely refused to recognize, or foster, or even tolerate these differences. In consequence, she lost her colonies.

In general, why men deliberately plan wars is because they are different biologically, in structure, habits, mental outlook, thought, or other ways, and wish to preserve intact their differentiations. The more truly conscious they become of these group differences, the more likely they are to fight as groups. As soon as they attain the first glimmerings of such consciousness they are apt to see, or to think they see, something in the behavior of their neighbors which threatens the maintenance of that which begins to mark them as a nationality. It is the business of their national leaders to be on the lookout for such things. They may merely fancy that they detect some danger to the maintenance of even their present status in something that a neighboring nation does. It may be a very intangible thing, and the interpretation of its significance may be entirely wrong, but that does not matter. The fighting promptly follows.

But someone will ask: *Why* does fighting follow? Why not arbitration or some other peaceful means of settling what is in many cases, at least, merely a trivial difference at the start? The biological answer is again clear. The human animal, in common with other higher vertebrates, has come to be endowed with emotions, of which rage is a very important one. In the intercourse of men and nations such things as insults, real or fancied, triflings with honor, either individual or national, attempted interference with natural or vested rights, larceny of territory or other goods—all these and similar sorts of activity vastly too numerous to catalog, tend to call forth the emotions of anger or rage. More particularly are acts of the sort mentioned sure to stir the emotions of a people if they are perpetrated by foreigners, those who do not belong to the same group. People of one's own kind may with impunity do things which another kind of people cannot do without exciting very violent emotions. The significant

biological fact is that, however induced, the emotion of rage automatically and inevitably causes certain definite bodily changes and activities, as has been demonstrated by the brilliant researches of Dr. Walter B. Cannon, described in his remarkable book entitled *Bodily Changes in Pain, Hunger, Fear and Rage*. The bodily changes induced by rage are precisely those which make the organism ready for a fight. They are the visceral preparation for the translation of emotion into action. The researches of Cannon have shown, as he says, "a number of unsuspected ways in which muscular action is made more efficient because of emotional disturbances of the viscera. Every one of the visceral changes that have been noted—the cessation of processes in the alimentary canal (thus freeing the energy supply for other parts); the shifting of blood from the abdominal organs, whose activities are deferable, to the organs immediately essential to muscular exertion (the lungs, the heart, the central nervous system); the increased vigor of contraction of the heart; the quick abolition of the effects of muscular fatigue; the mobilizing of energy-giving sugar in the circulation—every one of these visceral changes is *directly serviceable in making the organism more effective in the violent display of energy which fear or rage or pain may involve.*" It is clear that we have here a first class reason why men fight. It is, in short, because they get mad at each other. It is fair to say that this has been suspected for some time past. What the physiologist has shown us that we did not know before, however, is the reason why rage is more generally followed by fighting than by judicial arbitration.

No interested person or nation was ever known publicly to allege any such reasons as those just discussed for participating in war. That fact, however, may with safety be taken not to invalidate the point. Most men are human and a liking for the outward trappings of inner grace is a highly human attribute. As war begins, and while it continues, even on to the final ending around the table of the peace conference, everyone involved alleges a wide variety of highly moral reasons as to why he is participating. As a matter of fact, he perfectly well knows, if he is at all intelligent, and at all given to facing the actual facts as they are, that the

high principles have absolutely nothing to do with the *reasons* for his fighting. They serve a wholly different and much more useful and admirable purpose, in that they *justify* instead of explaining his belligerency. The explanation of why men fight is very simple. It is, first, because their kind of people is different from other kinds; second, because they want to make sure that their kind shall either maintain or improve its status in the world, and that which is thought to ensure most certainly the maintenance and extension of group differences in the widest sense is relative politico-social domination by the group; and third, because of a general physiological law that certain emotions tend to lead to *action*. So long as men are capable of becoming enraged there is potential danger of a fight.

THE BIOLOGICAL CONSEQUENCES OF WAR

Any discussion of the consequences of war, from a biological standpoint, demands as a first requisite the consideration of natural selection in relation to war, or, as it is perhaps more commonly put, "Darwinism and war." German philosophers of all degrees of attainment have been particularly addicted to speculation in this field. The view commonly held is that in war we have practically the only existing agency of natural selection operating with full vigor upon the human species. It is contended that when two nations engage in warfare with each other the principle of the survival of the fittest accompanies the operation with all its traditional crudity and finality. No better exposition of this viewpoint can be found than that set forth by my friend and colleague, Vernon Kellogg, in his remarkable book *Headquarters Nights*, from the after-dinner remarks of the distinguished German biologist who figures in the narrative under the name "Professor Von Flussen." Kellogg expounds the philosophy of war after Von Flussen in the following words:

> The creed of the *Allmacht* of a natural selection based on a violent and fatal competitive struggle is the gospel of the German intellectuals; all else is illusion and anathema. The mutual-aid principle is recognized only as restricted to its application within limited groups. For instance, it may and does exist, and to positive biological benefit, within

single ant communities, but the different ant kinds fight desperately with each other, the stronger destroying or enslaving the weaker. Similarly, it may exist to advantage within the limits of organized human groups—as those which are ethnographically, nationally, or otherwise, variously delimited. But as with the different ant species, struggle—bitter, ruthless struggle—is the rule among the different human groups.

This struggle not only must go on, for that is the natural law, but it should go on, so that this natural law may work out in its cruel, inevitable way the salvation of the human species. By its salvation is meant its desirable natural evolution. That human group which is in the most advanced evolutionary stage as regards internal organization and form of social relationship is best, and should, for the sake of the species, be preserved at the expense of the less advanced, the less effective. It should win in the struggle for existence and this struggle should occur precisely that the various types may be tested, and the best not only preserved, but put in position to impose its kind of social organization—its *Kultur*—on the others, or alternatively to destroy and replace them.

That this is a fair and typical exposition of the views of German biological philosophers regarding war will be readily granted without argument by any evolutionist who is familiar with the literature in this field. The principle of natural selection was seized upon by no one with greater avidity than the Germans. The strictly mechanistic features of this doctrine, which Darwin himself seemingly always felt to be a potential source of weakness, were the very things which made the strongest appeal to the Germans. In the hands of Haeckel, and particularly Weismann, natural selection was developed into a complete philosophical system of biology, in which any lack of biological evidence regarding the actual operation in nature of the basic principle was more than compensated for by the wooden finality of the logic.

As years went on the German statesmen and political philosophers became acquainted with the content and possibilities of what their biological confreres had by that time come to call with considerable unction "Neo-Darwinism." They presently saw the great possibilities which the principle of natural selection offered in fostering and developing in the minds of the people the militaristic ideal, the will to conquer. For thirty years every German school boy and girl has been taught what natural selection means. This same glorious principle that the fittest alone shall survive, and its converse that the survivor is the fittest, have

been the corner stones on which modern Germany has been built. Various remote and far removed causes have been assigned as contributory to the present conflict, but one highly important cause—perhaps in a philosophical sense the most significant of all—has been very generally overlooked. I believe it to be literally true that the one event in the history of Western Europe which more than any other single one laid the foundation for the situation in which Western Europe finds itself today, was the publication in 1859 of a book called *The Origin of Species*. With what horror would that gentlest and kindest of souls, whose mind conceived and executed this work, have been filled could he have foreseen the frightful welter of blood which has resulted from the gross perversion of his views by German biologists.

Let us examine with some care the meaning of natural selection in its relation to war. In the first place, it must be remembered that nowhere in nature does natural selection, as indicated by modern careful study of the subject, operate with anything like that mechanistic precision which the German political philosophy postulates. In a recent paper read before the American Society of Naturalists, I presented a number of examples from the literature illustrative of this point, and I need not repeat them here. Nature often does not operate on the natural selection basis, though logically—at least in formal logic—it ought to. Much less does natural selection operate in a rigid and mechanical manner with reference to human affairs. It is perfectly clear that no war in this day and age is, in any proper sense of the word, literally a struggle for existence. The German people have from the beginning tried to make it appear that the present war is, from their standpoint, exactly this. They have insisted again and again that their national existence, their continued survival as a nation was threatened by their neighbors, but such a view has only to be stated to any fair-minded, unbiased person to prove its utter absurdity. Could anyone but a German seriously maintain that the French, or the English, or the Italians, or the Russians, would have wished for, or would have attempted if they could, the annihilation of the German people? Theoretically, such a feeling or desire is conceivable, but practically everyone knows that it did not exist. Normal human beings are simply not constituted that way.

Furthermore, military results are not, in fact, measured in terms of biological survival. History shows that defeated nations survive just as definitely and truly as conquering races or nations. No better example could be found of the fallacy of the completely mechanistic natural selection idea with reference to war than our own Civil War, which was the most severely and bitterly fought of any war in recent history before the present conflict. No question of biological survival was involved at any stage; it was a struggle to effect the survival or elimination of certain politico-social ideas held by one group of people and not by the other. These ideas were slavery and secession. One of the contending groups was defeated; no military decision can ever be more complete and final than was that reached in the Civil War. If military conquests or defeats ever mean biological survival or elimination the principle should have been exemplified in the Civil War. Yet as a matter of fact and of course the defeated group was not eliminated in the biological sense, but biologically survived, and not only survived, but has become as a group more active, more progressive, and more distinctly differentiated biologically than it was before the conflict.

Other wars at other times show the same things. Take the case of peoples subjugated by military conquests; they are not eliminated, but on the contrary they survive, using the word in its strict biological signification. The natives participating in the Indian mutiny suffered a stinging military punishment. Yet today the natives of India survive, and their institutions survive. Again, take another example: it was necessary for us some years ago to conquer in a military sense the Filipinos. The unpleasant task was accomplished in a thorough-going manner. A complete military decision was made, but the Filipinos were not biologically eliminated, and today have a significantly stronger and more real national feeling than probably ever before in their history.

Nearer events prove the same point. No more ruthless attempt at the biological elimination of a nation was ever made than that undertaken by the Germans against Belgium in the summer of 1914 and continued to the present time. Yet, does anyone, even a German, delude himself into the belief that the Belgian

people and the Belgian national feeling do not survive today, and will not continue to survive?

The plain fact in the matter is that the proudly ruthless philosophy of Treitschke and Bernhardi is not only immorally cruel, but also immortally stupid. This whole crude and mechanistic view of war as a process of natural selection is really most unbiological in that it takes no account of the most fundamental of human biological characteristics—namely, those which distinctively differentiate man from lower organisms, his mental and moral qualities. Biologically, nationality rests on the group spirit of the people, which in turn means differentiant variations ineradicably ingrained in their germ plasm. Nationality can only be eliminated in the biological sense by the complete and total destruction of the germ plasm of the people of the nation, because it depends upon things which are to a substantial degree, at least, unchangeably and permanently determined by that germ plasm. Killing a percentage of the male population on the battlefield is as silly as it is a pitifully sad method of attempting to destroy the germ plasm of a nation. What a defeated nation loses in war is simply its status in the international political hierarchy either temporarily or permanently. It suffers, broadly speaking, no fundamental biological loss. The Chinese today, after a century of hopeless military defeats which left them an inert and pacifist nation are just as truly and completely biologically differentiated as they ever were. A Chinaman is a Chinaman today, and as different from anybody else in the world, as he ever was. Contrast this with real biological elimination with which this Darwinian School of militaristic philosophy draws so false an analogy. What comparison exists between a Chinaman and a dinosaur? Natural selection operated with a real *Allmacht* on the dinosaurs to a finish that made literally true the proverbial statement of the wondering rustic about the giraffe: "There ain't no such animal." But the Chinaman hopelessly defeated and crushed in military affairs is still with us and quite capable of enjoying life in his peculiar way. He stands in the aggregate as a gigantic refutation of the much lauded claim which the Germans have made for the "fundamental biological basis of war."

While we are on this subject of natural selection, it will be well to examine into another aspect of the subject in its relation to war. It has been contended by various persons that war has an unfortunate selective action on the individuals engaged in it. The operation of war is supposed to be selective within the race for the elimination of the best and the preservation of the worst germ plasm. This is alleged on the general ground that the physically, mentally, and morally best of the youth of the nation are those most likely to take part in war in the first place, and in the second place, most likely, because of these characteristics, to be killed in the course of the conflict. Dire pictures have been drawn of the effect upon the race of engaging in war, through the supposed operation of this dysgenic selection. The more one examines the facts, however, the more is it apparent that the case has been very much exaggerated.

Many considerations lead to this conclusion. In the first place, the future of the race, in the narrowly biological sense, is solely dependent upon the continuity of its germ plasm. In the human species the germ plasm of the race is equally borne by both the males and the females. But, putting the very worst complexion on the dysgenic argument, the females of the race are not elimated in war. So that if we were to grant for the moment the contention that the best males of the race are killed off, it would still remain the fact that but very slight deleterious racial effect would result, because there would be left behind in the surviving females at least half of the total racial germ cells of all qualities. Mendel's principles of inheritance teach us that even in such an extremely unlikely circumstance that all the germ plasm borne in spermatozoa was at the end of the war of an inferior quality, it would still be possible through the operation of segregation to have again a preponderant stock of superior individuals after a few generations, provided there were no social restrictions on assortative mating, which, broadly speaking, there are not.

Furthermore, the hypothesis of racial degeneration by elimination of the best tacitly assumes that those males eliminated in battle have not left progeny before their elimination, whereas, as a matter of statistical fact, a considerable portion of them do

leave behind such progeny. Again it must not be forgotten that the whole of the population, both male and female, under about twenty years of age is left untouched by war, and available for the perpetuation of the race as they grow older. This means in statistical terms, that about 40 per cent of the total male population existent at any given moment, and in which all qualities of germ plasm, good, bad, and indifferent, are normally distributed, as in a random sample of the whole, are not even involved in war and hence stand no chance to be eliminated by its operation.

In the second place, even in the most destructive of modern wars the proportion of totally eliminated casualties to the whole population is not very great. Indeed, it is always found to be surprisingly small when reviewed dispassionately by the vital statistician after the war is over. To take the case of our own Civil War, the proportion of casualties to the total population was only 2 per cent, and even in proportion to the male population within the likely breeding period (say fifteen to fifty years of age) was slightly under 9 per cent. It is, of course, too early to obtain similar estimates for the present conflict.

In the case of the present war, there are still other considerations which make it clear that any putative, deleterious, selective effect of war on the races concerned will be insignificantly slight. In all of the nations involved the fighting men have been taken practically at random from the whole population so far as germinal variations are concerned. The sound biological principle of conscription operates to leave the distribution curve of germplasmic qualities essentially the same after the fighting men have been taken out as it was before. The high development of the mechanical aspects of the present war operates to the same end. Hand to hand conflicts, man against man, in direct physical struggle, are a relatively small part of the present as compared with earlier wars. The agents of destruction chiefly relied on in the present conflict are entirely impersonal and distribute their effects very largely at random. The whole mode of conduct of the present war operates to make the chances for elimination of the man carrying about within his soma the best germ plasm of

the race, not substantially greater than the chances of the individual bearing the poorest germ plasm.

CONCLUSION

Except for lack of time one might go on and consider other essentially biological problems of war. We have not discussed at all those fascinatingly interesting and important problems connected with the individual's part in the actual conduct of war. A nation which would systematically and thoroughly investigate such matters as what sorts of men, physically, psychologically, and morally, make the best fighters; what biological conditions, including internal states, environmental conditions in and behind the lines, conduce to most efficient fighting; how fighters should be fed to obtain the best results; and other like problems, would be in an extremely superior position in any conflict with a group not possessed of definite scientific information on these points. At present our information regarding such matters is very largely empirical. It should be said, however, that since America's entrance into this conflict a brilliant beginning has been made in the scientific study of certain of these problems, initiated and directed in large degree by Major Robert M. Yerkes. The final results of his work will be eagerly awaited not alone for their military value, but also for their purely biological interest and significance.

In conclusion, the thought I most wish to leave with you, and which I hope I have sufficiently elaborated and illustrated, is that while war is a biological business, to the problems of which the trained biologist could contribute much, it is *not* an absolute biological necessity. Nations neither lose nor gain biologically by war. But this does not mean that wars must not and will not be fought. As a biologist I can come to no other conclusion than that wars will occur in the future as they have in the past until such time as civilized man has become a different kind of animal than he now is. Happily every war advances him by some degree on the road to that much-to-be-desired goal.

ZOOLOGY.—*The land shells of the genus Amphidromus from the islands of the Palawan Passage.*[1] PAUL BARTSCH, U. S. National Museum.

My paper on *The Philippine Land Shells of the Genus Amphidromus*[2] has had the usual effect of stimulating collectors to transmit their shells to the United States National Museum for classification. In this instance we have been exceptionally fortunate in receiving a large sending of carefully labeled specimens collected by Mr. C. M. Weber, in the islands of Palawan Passage. These greatly needed shells throw a flood of light on the systematic problem of the complex that inhabits these islands and make it possible to give a positive statement about them. It will be remembered that I was forced to say in the paper above referred to: "I am quite perplexed by the following species [*Amphidromus quadrasi*] and feel at a loss as to the treatment that should be accorded to it."

Mr. Weber's material shows that on some of the islands off southern Palawan these mollusks present a most remarkable range of color variation and, what is more, show that similar types of coloration occur upon several islands. The present collection establishes beyond a doubt the fact that no matter how interesting they may be from a breeder's standpoint, systematically considered these color phases have no more significance than the *unicolor*, *unicincta*, *bicincta*, *tricincta*, amd *quadricincta* forms of *Helicostyla ovoidea* which I have found in a single brood of that species.

The group breaks readily into two divisions. In the first groop the tip is always white and the early whorls are flesh-colored, turning gradually to yellow which becomes intensified as the shell increases and is darkest immediately behind the aperture, or the yellow may be replaced by green. A very narrow light line marks the summit of the turns below which a deep-maroon band encircles the whorls; the base at the columellar border is also edged with this color, while the lip is always white. This is *Amphidromus quadrasi* Hidalgo. This species, so far, is known from three islands, Candaraman, Coxisigan, and Bekin.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Bull. 100, U. S. Nat. Mus., Vol. 1, pt. 1, pp. 1–47, pl. 1–22, 1917.

Measurements of a large series of specimens from these islands show that there is a decided difference in the size of the specimens obtained on the three islands. The difference is probably best expressed in table 1.

TABLE 1

LOCALITY	NUMBER MEASURED	NUMBER OF WHORLS	ALTITUDE	GREATER DIAMETER
Candaraman	17	6.87	35.91	17.76
Caxisigan	65	6.72	33.53	17.12
Bekin	73	6.42	30.50	15.95

These differences I consider sufficient to demand a trinomial designation. The specimens from Candaraman are *Amphidromus quadrasi quadrasi* Hidalgo, the type locality for this subspecies. Those from Caxisigan may be known as *Amphidromus quadrasi caxisiganensis* Bartsch[3] and those from Bekin as *Amphidromus quadrasi ledyardi* Bartsch.[4]

The second group we may consider typified by *Amphidromus versicolor* Fulton. Specimens of this group always have the extreme tip dark brown; the rest of the turns may be white, pale yellow or wax yellow, or variously variegated; in the latter case the two or two and a half turns succeeding the dark tip are usually uniformly flesh-colored, while the ground color of those following may be white, yellow, green, or red, or sometimes several of these colors, one overlying the other, may be present; in each instance, if otherwise than white, the tint gradually becomes intensified toward the aperture. The whorls between the first two and the last may be unicolor or they may be marked by axial lines, bands, or forked flammulations of chestnut brown. The base may be unicolor or spirally banded with yellow, green, brown, or red. The columellar area may be white or edged with yellow, green, brown, or red. The lip may be white, pink, or purple, while the interior ranges from white through pearl gray, pink, pale purple, to spinel red. The general impression which one gains by looking at a tray of mixed specimens is a rainbow effect.

[3] Type, Cat. No. 215603, U. S. National Museum.
[4] Type, Cat. No. 215606, U. S. National Museum.

Amphidromus versicolor Fulton is now known from Balabac, Mantangule, Bancalan, and southern Palawan, all much larger islands than those occupied by *Amphidromus quadrasi* Hidalgo.

In spite of the great general variability of the color pattern, certain phases of coloration prevail on the separate islands which would enable one thoroughly familiar with these molusks to name with a fair degree of accuracy the island from which a specimen was derived. Measurements of a large series of specimens from the various islands give the results shown in table 2.

TABLE 2

LOCALITY	NUMBER MEASURED	NUMBER OF WHORLS	ALTITUDE	GREATER DIAMETER
Balabac	199	6.65	37.88	18.89
Bancalan	255	6.63	37.44	18.75
Mantangule	63	6.51	34.01	17.33
Palawan Passage	3	6.93	39.86	19.93
Palawan, Brooks Pt.	25	6.77	38.26	19.66
Palawan, Mt. Landargung	2	6.80	38.60	20.60

The shell described by me[5] from "Palawan Passage" as *Amphidromus quadrasi palawanensis* yield measurements that agree nearest with those of *Amphidromus versicolor everetti* which comes from southern Palawan. They also agree with this in having a remarkably uniform color pattern and dark coloration both outside and within, but they lack the obsolete peripheral angle characteristic of all the Palawan shells seen. It is unfortunate that we do not have a definite island locality for them.

The dark-colored race from the low lands of southern Palawan will have to be known as *Amphidromus versicolor everetti* Fulton, and it is more than possible that the shell described as *Amphidromus quadrasi solida* Fulton from Palawan will prove to be simply a color phase of this race. I have not seen specimens of it from Palawan. The forms I called *Amphidromus quadrasi solidus* in my paper from Balabac must now be placed with *Amphidromus versicolor versicolor* Fulton. The main coloration of *Amphidromus versicolor everetti* Fulton is very similar to my *Amphidromus*

[5] Bull. 100, U. S. Nat. Mus., Vol. 1, pt. 1, pp. 39–40, pl. I, fig. 15, pl. 20, figs. 1, 4, 6, 9. 1917.

versicolor palawanensis, but the presence of a peripheral angle separates it from that subspecies.

From Mt. Landargung, in the interior of southern Palawan, we have seen two specimens collected at an altitude of 2,500 feet which, while they agree in general coloration with *Amphidromus versicolor everetti*, are nevertheless much lighter in tone than that form, and the interior, instead of being purplish, is white. The edge of the lip is dark purple.

This mountain race deserves to be recognized by a trinomial name, and I will call it *Amphidromus versicolor monticolus*. The type[6] had 6.7 whorls and measures: altitude, 40.3 mm., greater diameter, 21.2 mm.

The greatest range coloration is presented in the forms from Vancalan Island, which may be known as *Amphidromus versicolor higginsi* Bartsch.[7] A selected series shows no less than twenty-eight types of coloring, which I shall describe briefly.

1. Tip dark, the ground color white, with a greenish suffusion which is most pronounced on the parietal callus.
2. Wax-yellow, a little lighter on the early whorls, with a greenish tint on the last; tip dark.
3. Midway in coloration between the last two but with an obsolete angle at the periphery.
4. Tip dark, the next white with a yellowish suffusion; last whorl gradually turning green; edge of the lip maroon.
5. Like the last. In addition, however, all but the first two and a half and the last one and a half turns, are marked by axial flammulations of chestnut brown.
6. Like no. 4, but with the early whorls wax-yellow, and the lip white.
7. Like the last, but the first three postnuclear turns show faint, light brown axial flammulations in addition.
8. Tip dark, the first two and a half turns flesh-colored; the two and a half succeeding these with flesh-colored ground upon which strong, axial, branching flammulations of chestnut brown are placed; the rest is wax-yellow turning greenish on the last turn. The last two and a half turns are encircled by a narrow zone of carmine at the suture, which color also surrounds the insertion of the columella.
9. Tip dark; all but the last four-fifths of the turns pale wax-yellow, the last portion marked by closely spaced dense axial streaks of varying

[6] Cat. No. 218795, U. S. National Museum.

[7] Type, Cat. No. 218420, U. S. National Museum.

shades of brown overlaid with a suffusion of pale green; lip maroon; umbilical area wax-yellow.

10. Like the above, but the dark coloration extends attenuatedly back over the last one and a quarter turns. The lip, also, is white.

11. Like no. 9, but with very pale yellow ground color. The space between the second and the last three-quarters of the last turn is marked by axial flammulations.

12. Like the above, excepting that the ground color and the lip are white. Columellar callus pale yellow and the solid color of the last portion of the shell extending over one and a quarter turns.

13. Tip dark; early whorls flesh-colored, those succeeding pinkish flesh-colored with obsolete axial flammulations of pale brown; last turn grenadine pink with a yellowish suffusion. Inside of aperture pale hermosa pink; edge of peristome dark purplish brown.

14. Tip dark; next two whorls flesh-colored, the two and a half succeeding flesh-colored with light chestnut brown axial flammulations; last turn wax-yellow; periphery angulated; base with two equally wide chestnut brown spiral bands of which one is immediately anterior to the periphery while the other is situated a little anterior to the middle of the base. These bands do not extend over the last half of the base. Peristome and interior white.

15. Like the last, but with the last turn deep wax-yellow gradually turning to green near the aperture. The two basal bands scarcely extend beyond the edge of the lip.

16. Like no. 13, but with a broad, wax-yellow spiral band whose posterior edge touches the posterior angle of the aperture. A second wax-yellow band marks the columellar area.

17. Like the last in coloration of the spire; base wax-yellow except the narrow band of grenadine pink immediately below the angulate periphery and a second one of the same color, which is situated on the center of the base, which evanesces before it reaches the middle of the last half turn.

18. Tip dark; the next two turns flesh-colored; all the rest except the last three-quarter turns of the last whorl flesh-colored with many axial, chestnut brown flammulations and a narrow subsutural wax-yellow zone. The last turn gradually darkens to olive green near the aperture. Aperture pale grayish blue within; peristome edged with blackish purple. A broad yellow band encircles the base at the posterior angle of the aperture and extends a little beyond its outer lip.

19. Like the last, but with the peristome white.

20 Similar to the last, but with the last whorl of much lighter color.

21. Similar to the last, but with the last whorl much lighter in color, greenish, purplish, and yellowish shades prevailing. The base, also, is wax-yellow and the lip is white with a purplish tint.

22. Tip dark; the next two turns flesh-colored; the rest at first with flesh-colored ground color which gradually gives way to yellowish, marked by many chestnut brown axial flamulations. On the last turn the axial color bands gradually become fused resulting in a dingy brown-

olive patch on the middle of the turn behind the aperture. The area near the summit of the whorls remains pale wax-yellow. Base with a narrow spiral chestnut brown band whose posterior border touches the posterior angle of the aperture; this is succeeded by a broad, yellow spiral zone, and this in turn by an equally wide spiral brown band, while the columellar area is a greenish and pinkish yellow. Lip white.

23. Like the last, but with the subperipheral spiral band double.

24. Like no. 22, but with the base dark chestnut-brown and a spiral mid-basal wax-yellow band, the columella area wax-yellow.

25. Tip dark; the two first turns flesh-colored; the ground color of the rest pale wax-yellow excepting the last turn, which is wax-yellow. All except the first two, and the last half of the last turn are marked by axial chestnut-colored flamulations. The last turn has fine spiral lines of chestnut brown. Base with a subperipheral and median band of dark chestnut brown, the rest wax-yellow excepting a pinkish line at the insertion of the columella. This line is also carried around the inner lip of the aperture, the inside of which is pale pinkish white.

26. Tip dark; the first two whorls flesh-colored; the ground color of the succeeding turns flesh-colored, this on the last whorl slowly giving way to pale yellow. All but the first two whorls marked by chestnut-brown axial flamulations, which, on the last turn, do not terminate at the periphery but extend over the base. These axial markings become condensed immediately behind the lip and render this portion almost unicolor. The inside of the aperture shows the dark color bands of the exterior. The peristome is white, but the inner edge of the lip is marked by purplish dark chestnut-brown bands.

27. Similar to the last, but of much more yellowish color, and with the axial flammulations much broader. These axial broad bands form an angle as they pass over the periphery. The insertion of the columella is encircled by a dark chestnut band.

28. Similar to the last but with the base largely dark excepting a broad pinkish band a little anterior to the periphery. This band becomes evanescent before it encircles half of the last turn.

The shells from Mantangule Island, which may be called *Amphidromus versicolor weberi*,[8] are by far the most brilliantly colored of all the known races of *Amphidromus versicolor*. However, we have here a much more uniform color pattern than in the specimens in the races from Balabac and Bancalan. All the specimens have a dark tip which is succeeded by two or more flesh-colored turns. The ground color of the succeeding turns may be flesh-colored, tinged with yellow or wax-yellow. In the one type of coloration no axial flammulations of chestnut brown are present on these whorls, while in the other they are strongly marked.

[8] Type, Cat. No. 218422, U. S. National Museum.

The last turn is usually light near the summit, then girdled with a broad, dark area which is of the same color as the dark area of the base but is separated from this by a narrow light zone at the periphery. The dark coloration of the last turn may be green or light coral-red or the latter overlaid with green. The base may be unicolor, i. e., white, yellow, green, red, or brown, or it may have one or two bands of yellow, brown, or red. The portion of the last whorl adjoining the columellar callus is usually coral-red. The interior is white, bluish, or pinkish, the peristome white or edged with purplish brown.

The table on page 363 gives additional data as to number of whorls and shell measurements.

The specimens which I have seen from Balabac Island show a lesser variability in coloration than those from Bancalan, to which they bear the greatest resemblance. There is here a much greater tendency to spiral banding of the base than in the shells from any of the other islands. All of the specimens of *Amphidromus versicolor weberi* examined have a white peristome but in *Amphidromus versicolor higginsi* this is frequently dark. In measurements they agree best with the shells from Bancalan Island, i.e., *Amphidromus versicolor higginsi*.

The present sending by no means completes the survey of the Palawan Passage region, for as yet we know nothing of the *Amphidromus* inhabitants of the three large islands Bugsuk, Pandanan, and Ramos, nor do we know anything about the group on the lesser islands of Apo, Bowne, Canimeran, Patongong, Gabung, Byan, Canabungan, Secam, Malinsono, Sanz, and Paz. Then, too, the many islands off the north coast of Borneo should contribute a large amount of information that should tell us something of the derivation of the forms in our domain which are undoubtedly of Bornean stock.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this JOURNAL and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

ELECTRICITY.—*Radio instruments and measurements.* Bur. Stand. Circ. 74. Pp. 330. 1918.

The Bureau of Standards has issued a treatise on radio measurements, for use by Government officers, radio engineers, and others concerned. The circular includes a development of the essential theory of high-frequency measurements from simple but precise low-frequency theory, the use of reactance curves in the rapid solution of problems, descriptions of radio instruments, and formulas and data for radio work. The full treatment of fundamental principles will make this circular serve as a foundation for later publications which may be issued by the Bureau on the general subject of radio communication.

J. H. D.

TECHNOLOGY.—*Stabilized-platform weighing scale of novel design.* F. J. SCHLINK. Bur. Stand. Tech. Paper No. 106. Pp. 28. 1918.

In this new scale the usual stabilizing element consisting of a pin-and-link connection is replaced by a flexible elastic tape, band, or wire. This design eliminates practically all the friction inherent in existing stabilizing mechanisms. In stabilized-platform scales made after the new design, friction is reduced to a very small amount, and is unaffected by the position of the load.

In the paper the earlier types of stabilizing elements are illustrated and the limitations of each set forth. The theoretical considerations underlying the conditions of equilibrium in weighing scales of the stabilized-platform type are defined and the methods used in carrying out the adjustment of such a scale are outlined. A discussion of the effects of static friction on the indications of scales is included and the effect of the elimination of this friction in enhancing the accuracy of weighings is shown. The paper includes nearly a score of illustrations of weighing scales and scale details.

F. J. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 804th meeting of the Society was held at the Cosmos Club, March 30, 1918; Vice-President HUMPHREYS in the chair; 53 persons present. The minutes of the 803d meeting were read in abstract and approved.

Mr. D. L. HAZARD presented the first paper, on *The magnetic survey of the United States.* The magnetic survey of the United States may be said to have had its beginning in 1843, when a plan for the reorganization of the survey of the coast was adopted which provided for making magnetic observations, but progress was slow up to 1899, because of lack of funds. Beginning with that year an annual appropriation of $25,000 has made possible a systematic survey of the whole country. The plan under which the work has been executed provides for magnetic observations at places 30 to 40 miles apart on the average; a subsequent more detailed investigation of areas of local disturbance; the occupation of a sufficient number of repeat stations to determine the secular change of the magnetic elements; and the operation of magnetic observatories.

The work has progressed to the point where observations have been made at all but about 150 county seats, results being available for about 5,500 stations, and attention is now being directed more especially to the investigation of areas of local disturbance and the occupation of repeat stations. Magnetic surveys have been made of Porto Rico, Hawaii, and the Philippines and the accessible portions of Alaska. Observations at sea have been made on some of the vessels of the Survey. Meridian lines have been established at many stations, and at most of the others the necessary information has been secured to enable local surveyors to test their compasses.

The results of the survey have been published from time to time, as the work progressed, in the form of magnetic tables and magnetic charts, the latest publication, just issued, being *Magnetic Tables and Magnetic Charts for 1915*, containing the accumulated results to the end of 1915.

While the survey had its origin in the needs of the navigator and surveyor, yet the importance of the scientific side has been kept in view from the outset and due attention has been given to securing the data needed for a comprehensive study of the earth's magnetism, with a view to determining its origin and the cause of its fluctuations.

The paper was discussed by Messrs. BAUER and HUMPHREYS.

The second paper was presented by J. P. AULT, on *Cruises III and IV of the yacht "Carnegie" in the Arctic and Sub-Antarctic regions, 1914 to 1917.* Motion pictures were shown of the different operations on board the vessel, of her passage through the Panama Canal, and of the rough seas and large icebergs encountered during the Sub-Antarctic cruise.

A brief summary was given of the origin and development of the science of terrestial magnetism, of its relation to the other sciences, and of its use and importance in present day activities. The work of the Department of Terrestrial Magnetism of the Carnegie Institute was described and a chart was exhibited which showed the region thus far surveyed, both on land and at sea. The general magnetic survey of the globe has been practically completed so that an early publication of new and accurate magnetic charts is contemplated.

For the ocean survey work a special vessel, the yacht *Carnegie*, was designed and built, being constructed wholly of nonmagnetic material. The results of observations made on board this vessel do not require corrections on account of magnetic material in the vessel. The *Carnegie* has completed four cruises since her launching in 1909, and has covered over 240,000 nautical miles. Cruises III and IV were planned to fill in the unsurveyed regions in the Arctic and Sub-Antarctic oceans, which are accessible to a sailing vessel of her construction. In 1914 during Cruise III, the vessel reached the high northerly latitude of 80°, west of Spitsbergen, the ports of call being Hammerfest, Norway, and Reykjavik, Iceland. Due to the small number of previous observations made in these regions, the errors in the existing charts were found to be quite large. A brief account was given of the results obtained, methods used, and of the peoples and places visited.

Cruise IV began at New York in March, 1915, and ended at Buenos Aires, Argentina, in March 1917. During this cruise the *Carnegie* passed through the Panama Canal, cruised in the Pacific Ocean from Honolulu to Dutch Harbor, Alaska, and northward into the Bering Sea to 60° north, and thence southward to Lyttelton, New Zealand. From Lyttelton a remarkable circumnavigation cruise was made, the Carnegie sailing eastward for four months, completely circling the Antarctic Continent in one season, returning again to Lyttelton. During this time the vessel was in the iceberg region for three and one-half months and encounterd very stormy weather. Gales of force 7 to 11, Beaufort scale, were experienced on fifty-five days out of 117, and some form of precipitation occurred on one hundred days. In spite of the adverse conditions, observations for magnetic dip and intensity were made every day, and observations for magnetic declination were made every day except one. In one region the chart errors increased to 12° for the British and American charts, and 16° for the German chart, the latter being an older chart than the former two.

The paper was discussed by Messrs. BAUER and HUMPHREYS.

After adjournment at 10 p.m., light refreshments were served.

E. C. CRITTENDEN, *Corresponding Secretary.*

The 805th meeting of the Society was held at the Cosmos Club, April 13, 1918; President BURGESS in the chair; 49 persons present. The minutes of the 804th meeting were read in abstract and approved.

The first paper was presented by S. J. MAUCHLY, on *A study of pressure and temperature effects in earth-current measurements.* (Illustrated by lantern slides). The larger portion of the earth-current data on record, was obtained from observations made on commercial telegraph lines. For lines of considerable length, the fluctuations in the observed current are generally assumed to be very little influenced by local effects at the earth plates, but for measurements made between electrodes not many kilometers apart, this assumption is not valid. Most of the special lines installed for the study of earth-current phenomena are necessarily limited in extent, and the object of the experiments described in this paper was to investigate the nature and order of magnitude of some of the spurious effects which may function under these conditions.

In one group of experiments a method similar to that used by Des Coudres, in his study of the E.M.F. produced by the action of gravity in salt solutions, was used to investigate the possible presence of an effect due to difference of pressure at the electrodes. It was found that a tube filled with soil and provided with an electrode at either end showed a component of the total E.M.F. which tended, when the tube was vertical, to form a cathode at the lower electrode regardless of which electrode was involved. The order of magnitude of this effect was shown to be sufficient to account for certain observed phenomena which appear inconsistent with physical principles, provided the effect exists as a general phenomenon in nature.

The results of continuous measurements of P.D. and temperature difference made on actual underground systems of earth plates for about eight months show that most, if not all, of the diurnal variation which has by some observers been ascribed to a vertical earth current was very probably due to the variations in the temperature difference between the electrodes.

The spurious effects introduced by temperature-difference variations were found to be greatly increased and reversed in sign when the soil in contact with the electrodes was frozen.

While the results are strictly applicable only to the actual installation employed during the experiments, they show that the effects which may result from temperature difference at the electrodes of an earth-current line, and from the variations in this difference, may for short lines be of the same order of magnitude as the quantities to be measured and with which they are associated. Some of the phenomena which various observers have ascribed to a true earth current must be largely influenced by such effects. The employment of nonpolarizable electrodes does not prevent the introduction of temperature-difference effects.

The paper was discussed by Mr. BAUER.

Mr. M. SASULY then presented the second paper, on *A general system of approximate integration formulae.* Several types of quadrature for-

mulas are known for evaluating definite integrals of functions whose primitives are unknown. The most familiar formulas are those developed by Cotes, Lagrange, Euler, and Gauss. In each of these the problem is reduced to finding a certain area under a curve representing the function in rectangular coordinates. This area is given in terms of the interval of integration and several ordinates (values of the function) within that interval. Thus, to a certain degree of approximation,

$$\int_a^b f(x)\,dx = (b-a)\sum_{i=1,2,3,\ldots n}[k_i \cdot f(x_i)]. \tag{1}$$

The numbers $f(x_i)$ and k_i are ordinates and corresponding "weighting" coefficients in the interval $(a \ldots b)$.

In the formulas of Cotes and Euler the ordinates are equidistant. In those of Lagrange the ordinates may be taken at random. All three types have equal accuracy of a certain kind, namely, a formula using n ordinates gives the exact value of definite integrals of a polynomial function of degree n—1 (or degree n if n is odd). In the formulas of Gauss, however, the ordinates must be taken at certain definite points, and in virtue of this the maximum accuracy is obtained. A formula of n ordinates is exact for the integral of a function of degree $2n$—1.

It can be easily shown that the use of any type of ordinate formula is valid only in the case of analytic functions (i.e., such as can be developed in a convergent power series). From the properties common to all analytic functions, it may be shown that the points x_i and the coefficients k of the corresponding ordinates subsist in a unique functional relation. Thus by a simple transformation, we may put

$$\int_a^b f(x)\,dx = \int_{-1}^{+1} \varphi(t)\,dt. \tag{2}$$

Then, it can be shown that

$$\int_{-1}^{+1} \varphi(t)\,dt \doteq 2 \cdot \sum k_i [\varphi(-r) + \varphi(+r)] \tag{3}$$
$$i = 1, 2, 3, \ldots n,$$
$$0 \leq r_1 < r_2 < r_3 \ldots r_n \leq 1,$$

in which the numbers k_i and r_i are each arbitrary but related as follows:

$$\sum_{q=0,1,2,3\ldots n} k_i \cdot r_i^{2q} = \frac{1}{2(2q+1)}. \tag{4}$$

This relation determines an infinite number of types of approximate integration formulas, combining maximum accuracy with maximum flexibility. For k_i and r_i may have arbitrary values, consistent with their fundamental relation, and subject only to the condition that the

ordinates be selected in pairs symmetrically located in the integration interval. The formulas of Cotes, Euler, and Gauss may be derived as special cases.

The paper was discussed by Messrs. SOSMAN, WHITE, and BURGESS.

A third paper, by P. D. FOOTE and F. L. MOHLER, on *Ionization and resonance potentials for electrons in vapors of magnesium and thallium*, was presented by Mr. Mohler. (Illustrated by lantern slides). Since mercury, magnesium, cadmium, and zinc belong to the same family, one might expect that the behaviour of electrons in vapors of these four elements should be somewhat similar in character. The single line spectrum of mercury is known to be excited at the resonance potential of 4.9 volts. Work of Tate and Foote reported at the Chicago meeting of the Physical Society, shows that the resonance potentials for cadmium and zinc obey the quantum relation $h\nu = Ve$, where ν is the frequency of the single line spectrum. Hence, one would expect the single line spectrum of magnesium to follow a similar relation.

The present writers have employed the method of Franck and Hertz for determining the resonance potential of electrons in magnesium vapor and Tate's modification for determining the ionization potential. The mean of data so far obtained gives 2.65 volts for resonance and 7.75 volts for ionization with an accuracy of possibly 0.1 volt. The theoretical values on the basis of $\lambda = 4{,}571$ and 1,622 are 2.70 volts and 7.75 volts, respectively, while the single line spectrum at $\lambda = 2{,}852$ would require a resonance potential of 4.3 volts. This experiment combined with the confirmed results on the other metals in the same group suggests that the single line spectrum of Mg is $\lambda = 4{,}571$ rather than $\lambda = 2{,}852$. Evidence was obtained in the present work for a series of double points in the current-potential curves similar to those found by Tate and Foote for zinc, but further work now in progress is required properly to interpret these subsidiary points.

The resonance and ionization potentials for electrons in thallium vapor have been measured by the method described in earlier papers, with the modification of the use of a hot equal potential surface instead of a hot wire as a cathode. The cathode was similar in principle to that used by Goucher and consisted of a platinum (or better, a nickel cylinder) insulated from a helix of tungsten wire inside, which was used as the heater. Ionization occurred at an applied potential of 6.6 volts, which when corrected for the initial velocity observed as 0.7 volts gives the final value for the ionization potential of 7.3 volts. The thallium spectrum is characterized by a set of doublet series. The resonance potential of 1.07 volts is given within experimental errors by the quantum relation $h\nu = eV$ when ν is the frequency of the stronger line ($\lambda = 11{,}513$) of the first doublet of the principal series. The theoretical value of the resonance potential computed on this basis is 1.07 volts. We believe this is good evidence that the single line spectrum of thallium is $\lambda = 11{,}513$.

We were unable to detect any sign of ionization accompanying resonance or any resonance due to the line $\lambda = 13{,}014$. If thallium acted

in a manner similar to sodium or potassium one would expect from the analagous relations in the series of these elements to find ionization determined by the quantum relation $h\nu = eV$ when ν is the limit of the principal series $\nu = 22{,}786$. This requires a value of $V = 2.81$ volts, which cannot be considered in the light of the experimental data.

We believe that our work enables the prediction of a new series in thallium. It is very possibly of the form $\nu = 1.5\ S - mP$, a single line series of low intensity converging at 1.5 S lying between 57,000 and 60,000. The highest convergence frequency of any series so far known for thallium is 49,263. The present work again brings up the question of the separate excitation of lines constituting a doublet. Thallium appears to offer a fruitful field for work in this regard.

Although the usual time of adjournment had arrived, it was moved and carried that the program be completed, and Mr. P. D. FOOTE presented a paper on *Electronic frequency and atomic number*, which was discussd by Dr. SWANN.

The meeting adjourned at 10.15 p.m.

H. L. CURTIS, *Recording Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 584th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 20, 1918; called to order at 8 p.m. by President ROSE; 35 persons present.

General T. E. WILCOX stated that he had received a communication from Ex-President Roosevelt in which he said he was presenting to the Society an autograph copy of his book entitled *A Booklover's Holiday in the Open*. Dr. Howard in this connection referred to the 277th meeting of the Society when Theodore Roosevelt, then Assistant Secretary of the Navy, attended for the first and only time a meeting of the Biological Society of Washington.

The regular program was as follows:

ALEX. WETMORE: *Lead poisoning in waterfowl.* Mr. Wetmore said that lead poisoning in waterfowl has been known for a number of years and recently has assumed considerable economic importance. Wild ducks, whistling swans and a few other birds subject to this disease pick up and swallow pellets of shot lying in the mud in marshes and shallow lakes about old shooting blinds. These shot are held in the stomach and worn slowly away by grinding against bits of gravel taken to aid digestion, so that small particles of lead are being steadily passed out into the intestine, and in part absorbed. This causes a severe diarrhoea, the feces are stained bright green, the birds are soon unable to fly, and a slow paralysis sets in so that they become unable to stand. Cases of long standing become much emaciated though the birds eat eagerly. By experiment it was found that six number six shot when swallowed were fatal in every instance, while in one instance one shot of that size was sufficient to cause death from lead poisoning. It was also shown that the trouble was due actually to lead and not to arsenic

or combinations thereof with lead. In all cases this lead poisoning seemed to result fatally, and on certain marshes a considerable number of waterfowl are destroyed in this manner. The speaker described the symptoms and post-mortem appearances fully and gave details of experiments and observations made in the laboratory and in field work. He also exhibited specimens of shot removed from the gizzards of ducks, showing how they had been worn by muscular action, and also shot dredged from the feeding grounds.

A. S. HITCHCOCK: *Generic types.* The speaker reviewed the tendencies in generic nomenclature of plants and referred to the rules concerning generic types in the American Code of Botanical Nomenclature. He also referred to the rules in the International Code which concern the use of the generic name although these rules do not recognize type species. Precision in the application of generic names is attained only when it is recognized that a genus, however limited as to component species, must include the type species. In other words, the type species of a genus should determine the application of a generic name. It is obvious that the type species is the species or one of the species included in the genus when it was established. It is recommended that the type species be designated when a new genus is published. Since the older authors in most cases did not designate their generic types, it becomes necessary to select the type species for the genera in which the types have not been designated. If there is agreement as to type species there will be agreement as to the application of generic names. Of course it does not follow that there will be agreement as to the limitation of genera. One concerns nomenclature, the other concerns taxonomy. Mr. Hitchcock has investigated 255 generic names of grasses and indicated their type species. Several examples were given illustrating the method of selecting the types.

The paper was discussed by Dr. L. O. HOWARD, W. L. MCATEE, and S. A. ROHWER.

W. W. EGGLESTON: *Thomas Nuttall's trip to Oregon in 1834, with notes on the route.* Thomas Nuttall was a member of Captain N. J. Wyeth's Second Oregon Expedition. Nuttall's data on localities is meager, therefore collections along his route would be useful. Collections should begin at Scotts Bluff and cover the country to the mouth of the Columbia. The more important places to visit are Scotts Bluffs, Nebraska, Laramie Mountains (Black Hills) along Platte River, Granger, Wyoming, Soda Springs, Idaho, Fort Hall (furtraders' fort), Idaho, Wildhorse Creek, Idaho, Blue Mountains, Oregon, and the region around Sauvies Island, Oregon.

In 1916 the Cusick Brothers and the writer studied the route across the Blue Mountains. This Indian trail led up Burnt River and Alder Creek to the vicinity of Pleasant Valley, where the party lost the trail. Proceeding northward the party crossed Powder River about six miles below Big Creek, passed the head of Cusick Creek, and on through Thief Valley, relocating the trail at the Powder River, crossing between North Powder and Telocaset. Thence the trail follows the foothills and along

the southern rim of Grande Ronde Valley to Ladd Canyon, thence drops into the Valley west of Hot Lake, and along the base of the rim to Le Grande where it crosses the mountains. The old wagon road from Le Grande through Meacham to Cayuse now marks this part of the trail.

In 1917, the trail west of Fort Hall was traced. It passed along Big Butte to Big Lost River, thence up Big Lost to the vicinity of Arco, Idaho, thence west to Antelope Creek and down the creek to Big Lost River again, thence up Big Lost, the East Fork, and Wildhorse Creek into Thornburg's Ravine. No pass being located here the party returned the next morning to the north fork and crossed the Sawtooth Mountains by the only pass in this vicinity, the pass now used by the wagon road. M. W. LYON, JR., *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 313th meeting of the Society was held at the Cosmos Club, May 2, 1918. The meeting was called to order by President SASSCER, with thirty-two members and three visitors present.

The following names were favorably acted upon for membership: Mr. C. A. WEIGEL and Mr. WM. A. HOFFMAN, both of the Bureau of Entomology.

The regular program was as follows:

W. D. PIERCE: *Medical entomology, a vital factor in the prosecution of the war.* This paper, which will be published in the Proceedings of the Society, deals with insects as disseminators of diseases of man and animals with special reference to the problems of army-camp sanitation. Following the reading of Dr. Pierce's paper the matter of the relation of entomology and entomologists to the health of our army was interestingly discussed by Dr. L. O. HOWARD and Mr. A. N. CAUDELL of the Bureau of Entomology, and Major ALFRED M. LUND, Captain ROBERT H. BROWN, and Lieutenant E. H. GIBSON of the army Sanitary Corps. The remarks of these army officers were especially appreciated, describing, as they did, actual experience in the practical handling of the perplexing problems of sanitary engineering in its entomological phases.

J. A. NELSON: *A microcephalic drone bee.* This interesting description of an extraordinary aberrant drone bee will be published in the Society Proceedings.

R. A. CUSHMAN: *A convenient method of handling large numbers of individuals in life-history studies.* Mr. Cushman described and illustrated the decimal system of keeping records of rearing experiments. His remarks were discussed by Messrs. HYSLOP, PIERCE, CAUDELL, and ROHWER.

H. G. BARBER: *The genus Plinthisus Latreille in the United States.* Read by title. A. B. GAHAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Maryland-Virginia-District of Columbia section of the Mathematical Association of America held its annual spring meeting on May 4, 1918, at the Catholic University. The following officers were elected for the ensuing year: *President*, A. E. LANDRY, of the Catholic University; *Secretary*, RALPH ROOT, of the Naval Academy; *third member executive committee*, L. F. HULBURT, of Johns Hopkins University.

Professor O. STEELS, of the School of Civil Engineering, University of Ghent, and Professor ALBERT VAN HECKE, of the Faculty of Sciences of the University of Louvain, arrived in Washington in May as members of the Belgian Mission on Industrial Management. Professor STEELS is President of the Mission.

An "Inventions Section" has been added to the organization of the General Staff of the army, "in order to secure prompt and thorough investigation of inventions submitted to the War Department." It is headed by an advisory board of chemical, electrical, and mechanical technologists. D. W. BRUNTON, Chairman of the War Committee of Technical Societies, is chairman of the Advisory Board of the new Section, and Dr. GRAHAM EDGAR and Lieut.-Col. R. A. MILLIKAN, of the National Research Council, are members.

The offices of the Chemical Service Section of the National Army have been removed from the building of the Interior Department to Unit F, Seventh and B Streets.

By an executive order issued May 11, 1918, the President of the United States requests the National Academy of Sciences, under its congressional charter, to perpetuate the National Research Council. The order defines the duties of the Council, which are, briefly: (1) to stimulate research; (2) to survey the larger possibilities of science; (3) to promote cooperation in research; (4) to bring American and foreign investigators into cooperation with the Government; (5) to aid in the solution of war problems; (6) to gather and collate information. The order further provides for the appointment by the President of government representatives as members of the Council, upon nomination by the National Academy, and instructs the heads of government departments to continue to cooperate with the council.

The Department of Terrestrial Magnetism of the Carnegie Institution of Washington, in accordance with a request from Captain ROALD

AMUNDSEN, has supplied for use in his forthcoming arctic expedition a complete set of magnetic instruments, as well as the necessary directions for magnetic measurements and the program of work. Captain Amundsen plans to leave Norway this summer in a new vessel, the *Maud*, built specially for arctic exploration, and has made his arrangements on the expectation that his expedition will require about five years for completion. He will make scientific observations of various kinds in the arctic regions. The final details with regard to the contemplated arctic magnetic observations were arranged at the laboratory of the Department by Dr. Nansen and Captain Amundsen on April 5.

On account of difficulties with transportation, Professor R. F. GRIGGS, of the Ohio State University, has been obliged to abandon his plan to lead another expedition this summer to Mount Katmai, Alaska, under the auspices of the National Geographic Society. The work planned for this summer has not been entirely abandoned, however, as two members of last year's expedition, Messrs. SAYRE and HAGELBARGER, left for Alaska on May 2, taking with them pyrometers furnished by the Geophysical Laboratory, with which it is hoped to obtain data on the temperatures of the fumaroles in the "Valley of Ten Thousand Smokes."

Chancellor SAMUEL AVERY, of the University of Nebraska, is now connected with the Division of Chemistry and Chemical Technology of the National Research Council.

Professor WATSON BAIN, professor of applied chemistry at the University of Toronto, is in Washington as a member of the Canadian War Mission.

Mr. H. A. BAKER, chief chemist of the American Can Company, is in charge of problems of tin plate supply at the U. S. Food Administration.

Lieutenant-Colonel HIRAM BINGHAM, formerly Professor of Latin American History at Yale University, is Chief of the Air Personnel Division of the Signal Corps.

Professor W. C. BRAY, of the department of chemistry, University of California, came to Washington in May to engage in research on war problems with the Bureau of Mines.

Dr. A. D. BROKAW, assistant professor of mineralogy and chemical geology at the University of Chicago, is on the staff of the U. S. Fuel Administration, in charge of oil production east of the Rocky Mountains.

Dr. JOSEPH A. CUSHMAN, of Sharon, Massachusetts, was in Washington for a few days in May, after several weeks of geologic field work in the coastal plain of North Carolina.

Mr. FRANCIS C. FRARY, of the Oldbury Electrochemical Company of Niagara Falls, has been commissioned a captain in the Ordnance Officers' Reserve Corps, and is engaged in research with the Trench Warfare Section, Engineering Bureau of the Ordnance Department, in Washington.

Dr. GROVE KARL GILBERT, one of the charter members of the Academy, died at Jackson, Michigan, on May 1, 1918, within a few days of his seventy-fifth birthday. He had been associated with the scientific life of Washington for forty-seven years, having been geologist of the Wheeler and Powell Surveys in 1871 and 1874, and one of the original staff of the present U. S. Geological Survey at its establishment in 1879. Dr. Gilbert was a member of the Geological Society of Washington, of which he was president in 1895 and 1909; the Philosophical Society of Washington, of which he was president in 1892; the National Academy of Sciences; and many other American and foreign scientific organizations. His broad-minded interest in the problems of the earth kept him an active investigator throughout his life, and his published papers cover almost the entire range of modern geological science.

Dr. HERBERT E. IVES, formerly of the United Gas Improvement Company of Philadelphia, has been commissioned a captain in the Signal Corps, and is attached to the Science and Research Division of the Signal Corps at 1023 Sixteenth Street, the headquarters of the National Research Council.

Lieutenant-Colonel C. F. LEE, in charge of the British Aviation Mission in Washington, who lectured before the ACADEMY in March on *Aviation and the war*, has returned to England for six weeks to inspect new models of aircraft.

Dr. VICTOR LENHER, professor of chemistry at the University of Wisconsin, has been commissioned a major in the Chemical Service Section, National Army, and is stationed in Washington.

Mr. P. W. MASON, formerly assistant professor of entomology at Purdue University, was appointed on May 1, 1918, scientific assistant in deciduous fruit insect investigations, in the Bureau of Entomology, Department of Agriculture.

Dr. FRIDTJOF NANSEN, special representative of the Norwegian Government, and an honorary member of the ACADEMY, returned to Norway on May 11, after signing the general commercial agreement between the United States and Norway which has been in negotiation for several months.

To Professor F. H. NEWELL, of the University of Illinois, formerly director of the U. S. Reclamation Service, the American Geographical

Society has awarded the Cullom Geographical Medal. Other recipients of the medal have been: Rear-Admiral PEARY, FRIDTJOF NANSEN, Sir JOHN MURRAY, the DUKE OF THE ABRUZZI, SVEN HEDIN, Sir ERNEST SHACKLETON, and General GOETHALS.

Mr. GEORGE A. RANKIN, formerly of the Geophysical Laboratory, is on leave of absence from the Pittsburgh Plate Glass Company and is engaged in research at the Experiment Station of the Bureau of Mines, at the American University.

Mr. C. E. VAN ORSTRAND, of the Geological Survey, returned in May from a field excursion in Texas, during which he made measurements of the temperatures in a new 4,600-foot well near the Damon salt dome, Damon, Texas.

Mr. RUDOLPH J. WIG has resigned from the Bureau of Standards in order to devote full time to his duties as chief engineer of the concrete-ship department of the Emergency Fleet Corporation.

Major ROBERT M. YERKES, formerly professor of comparative psychology at Harvard University, is attached to the Surgeon General's Office and is in charge of the psychological testing of drafted men for the National Army.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Mr. CARLETON ROY BALL, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. ROBERT ERVIN COKER, Bureau of Fisheries, Washington, D. C.

Mr. BERTRAND LEROY JOHNSON, U. S. Geological Survey, Washington, D. C.

Dr. LEO LOEB, Washington University Medical School, St. Louis, Missouri.

Professor ARCHIBALD BYRON MACALLUM, University of Toronto, Toronto, Canada; and Honorary Advisory Council for Scientific and Industrial Research, Ottawa, Canada.

Mr. DONALD FRANCIS MACDONALD, Ancon, Panama.